Rule-Governed Behavior and Human Behavioral Pharmacology: A Brief Commentary on an Important Topic

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Over 25 years ago, B. F. Skinner introduced the concept of rule-governed behavior, which is the topic of this commentary. To date, behavioral pharmacologists have given rule-governed behavior little consideration in their analyses of drug action. There are, however, published studies that demonstrate the importance of rule-governed behavior in modulating drug effects in humans. Rule-governed behavior may help to explain differences in drug self-administration in humans and nonhumans and, in humans, differences in drug effects across individuals and situations. This commentary suggests that rule-governed behavior merits further attention in the context of human behavioral pharmacology, and posits that scientists who are experts in verbal behavior can make a unique contribution to the theoretical and experimental analysis of drug-related human behaviors, including drug abuse and its treatment.

In two well-known books, *The Behavior of Organisms* (1938) and *Science and Human Behavior* (1953), B. F. Skinner proposed that behavior is lawfully related to environmental variables, therefore subject to scientific analysis. He also proposed a general strategy, the experimental analysis of behavior, for this analysis. For over three decades, behavioral pharmacologists have enthusiastically embraced the within-subject, operant conditioning methodology characteristic of the experimental analysis of behavior, especially in analyzing drug self-administration and drug effects on learning and performance (e.g., Blackman & Sanger, 1978; Harvey, 1971; Iverson & Iverson, 1975; Thompson & Schuster, 1968). In explaining drug effects they also have borrowed heavily from behavioral principles developed by Skinner. As an example, consider analyses of drug action that emphasize the reinforcing, discriminative, and other functional stimulus properties of psychoactive compounds (e.g., Thompson & Pickens, 1971).

The influence of Skinner's work on behavioral pharmacology is obvious (Poling, 1986). But it appears that behavioral pharmacologists have given one of his major theoretical contributions, the concept of rule-governed behavior (Skinner, 1966, 1969, 1974), little serious consideration. Most discussions of drug self-administration fail to consider the topic (for an exception see Bickel & Kelly, 1986), even when they are of high quality and written from a behavioral perspective (e.g., Goldberg & Stolerman, 1986; Griffiths, Bigelow, & Henningfield, 1980; Johanson, 1990; Katz, 1990). Moreover, with few exceptions (e.g., Malott & Garcia, 1991), behavior analysts interested in rule-governed behavior have not extended their theorizing to include drug-behavior interactions (see Hayes, 1989).

There is, however, a small but growing literature that deals directly with the modulation of drug effects by instructions (i.e., rules). One purpose of this commentary is to introduce studies in this area to people with an interest in rule-governed behavior who may not keep abreast of the behavioral pharmacology literature. A second purpose is to emphasize the possible importance of rule-governed behavior for human behavioral pharmacology. The final purpose is to suggest that scientists

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who are experts in the analysis of verbal behavior, many of whom read this journal, can make a unique contribution to the theoretical and experimental analysis of drug-related human behavior, including drug abuse and its treatment.

WHAT IS RULE-GOVERNED BEHAVIOR?

According to Skinner (1966, 1969, 1974), behavior can be either contingency-shaped or rule-governed. In essence, contingency-shaped behavior is behavior controlled by direct exposure to reinforcement or punishment. A rat that presses a bar in the presence of a tone, thereby administering cocaine to itself, is exhibiting contingency-shaped behavior. Of course, the probability that the rat will emit this behavior is influenced by the current context and a variety of historical variables, in particular the presence of a history in which bar presses in the presence of the tone produced cocaine injections.

In Skinner's analysis, rule-governed behavior is behavior controlled by the description of relations among responses and stimuli (rules, also termed instructions), rather than actual exposure to these contingencies. Unlike contingency-shaped behavior, rule-governed behavior only occurs in verbal organisms. A person who has never taken cocaine or a related drug, but does so for the first time after repeatedly being told, "try it - it's safe and will make you feel good," is exhibiting rule-governed behavior. Of course, the probability that the person will follow this rule is influenced by the current context and a variety of historical variables, in particular the presence of a history in which following similar rules under similar circumstances yielded positive consequences.

Several authors have suggested that rules have a discriminative stimulus (S^D) function (e.g., Baldwin & Baldwin, 1981; Catania, 1984; Galizio, 1979; Hayes, Brownstein, Zettle, Rosenfarb, & Korn, 1986, 1986; Vaughan, 1985). As usually defined, an S^D evokes a particular kind of responding because, historically, such responding was more successful in the presence of that stimulus than in its absence (Michael, 1982). There is no doubt that, given an appropriate history, verbal behavior can serve as an S^D. This function requires no special analysis with respect to drug action. For instance, the general finding that drug effects are attenuated when behavior is strongly controlled by an S^D (Laties, 1972, 1975; Thompson, 1978) should hold regardless of whether or not the S^D is a verbal rule (although this is not foregone and merits empirical test). And, given that a particular drug is momentarily reinforcing, the likelihood of drug-seeking and drug-taking behavior occurring should increase in the presence of an established S^D for those behaviors, irrespective of whether or not the S^D is a rule.

The novel, and noteworthy, aspect of rules is that, as Schlinger and Blakely have emphasized, rules are contingency-specifying stimuli that alter behavior by changing the function of other stimuli (Blakely & Schlinger, 1987; Schlinger & Blakely, 1987). Schlinger and Blakely (1987) provide detailed coverage of the function-altering effects of rules. In brief, in the context of operant conditioning, rules may alter (a) the evocative function of discriminative stimuli, (b) the evocative function of establishing operations (i.e., motivational variables, see Michael, 1982), (c) the reinforcing function of stimuli, and (d) the punishing function of stimuli. Rules can also alter the control of behavior by stimuli in respondent arrangements.

Although the functioning-altering effects of rules are in some cases subtle, in other instances they are quite powerful. Rules may, for instance, cause previously neutral or aversive stimuli to act as powerful positive reinforcers. If, for instance, a patron known to be monied and truthful announces in a bar, "I'll give $1,000 for each of the first 10 belches that I hear," it's a safe bet that the reinforcing value of loud self-generated belches will momentarily increase for many (but probably not all) patrons, including some who typically work hard to avoid belching.

Rules can also render neutral stimuli that previously served a behavioral function, or modify the behavioral function of those stimuli. Although control of behavior by direct-acting contingencies is ubiquitous in the everyday environment of most people, control by rules appears to be equally significant, at least for verbal adults in modern societies. As Guerin (1992) has emphasized, most of what such humans know, and much of what they do, is not contingency-shaped, but rule-governed. If you doubt this, consider why you confidently assert "it's 93,000,000 miles to the sun" and "the sun never sets during mid-summer above the Arctic Circle." Or why you don't drive on the left side of the road in the U.S.A., go to work naked, give your boss the finger, or drink on the job.

RULE-GOVERNED BEHAVIOR AND DRUG ACTION

To illustrate some important function-altering effects of rules in the context of human behavioral pharmacology, we will begin with a hypothetical experiment. Subjects are paid college students, each of whom smokes over a pack of cigarettes a day. They agree to reside on a residential ward for five consecutive days. Their access to various parts of that ward, to social interactions, and to cigarettes is controlled by the experimenter. Unless otherwise specified, each subject is given one cigarette every hour from 8 a.m. to 10 p.m., thus they are mildly cigarette deprived relative to baseline levels.

Each day, beginning at nine in the morning, subjects sit at a console that contains a telegraph key, red and blue stimulus lights above the key, and a cigarette dispenser. A progressive-ratio 50 (PR 50) schedule of cigarette delivery is arranged for presses of the key and, once responding is initiated, the session continues until two consecutive minutes elapse without a response. The primary datum is the breaking point, defined as the number of responses in the last ratio completed each session. Written instructions are provided on a note card taped above the key. Across five consecutive sessions, the following instructions (rules) appear on the card:

Day 1. You can earn cigarettes by pressing the key.

Day 2. You can earn cigarettes by pressing the key. Cigarettes are available only when the red light is on.

Day 3. You can earn cigarettes by pressing the key. The cigarettes that you earn by pressing the key will be the only ones available to you today.

Day 4. You can earn cigarettes by pressing the key. For each cigarette that you earn, you will be required to miss 15 minutes of the social period scheduled from 9 to 11 tonight.

Day 5. You can earn cigarettes by pressing the key. No cigarettes will be delivered now; they will be delivered at 8 tonight.

The day 1 instructions (rules) should establish responding similar to that produced by direct exposure to the contingencies described. On day two, the red light should control responding in a manner similar to an S^D. That is, far more responding occurs when that light is on than when it is off. On day 3, one would expect a higher breaking point than that obtained on the other days; the statement concerning cigarette availability serves as a motivational variable, increasing the reinforcing value of cigarettes. Assuming that social interaction is important to the subjects, relatively little responding would occur on day 4. Here, delayed aversive consequences reduce drug-seeking behavior. Considerable responding probably would occur on day 5, even though there is a substantial delay between responding and cigarette delivery. As with day 4, the provision of rules enables delayed consequences to affect behavior.

Contrast these performances with those likely to occur in the absence of rules. Sans rules, substantial key-press responding may or may not occur on day 1. If it did, the red light may have developed discriminative control over responding on day 2, although this would require a substantial period of time to occur. Behavior would not be affected by the restricted access arranged on day 3, or the delayed consequences in effect on days 4 and 5. Clearly, rules affect drug-related behavior in this example.

Rules also appear to affect drug-related behaviors in a sizeable number of published studies. Several of them examined the effects of verbal instructions on drug self-administration. For example, Frederiksen and Simon (1978) used a multiple-baseline design across components of smoking topography to evaluate the effects of verbal instructions on puff frequency and puff duration. Instructions were effective in decreasing puff frequency and duration and, consequently, the amount of each cigarette smoked and mean carbon monoxide uptake.

In another examination of the effects of instructions on the reinforcing properties of nicotine, Hughes, Pickens, Spring, and Keenan (1985) gave cigarette smokers concurrent access to nicotine and placebo gums during a period of abstinence from smoking. In the first experiment, subjects were told they would receive either nicotine or placebo gum. Under these conditions, they consistently administered nicotine but not placebo gum, which suggests that nicotine was serving as a reinforcer. Two subsequent experiments examined the possibility that subjects self-administered nicotine gum at a greater rate than placebo gum because they believed the gum with more side-effects (nicotine gum) was the active gum, not because the nicotine gum was more reinforcing. In the second study, subjects were told they would receive either a marketed nicotine gum or a different nicotine gum (actually placebo) that was as effective but had fewer side effects. In the third study, subjects were told that the placebo gum had more side effects than the nicotine gum. In both studies, subjects did not self-administer nicotine gum at a rate greater than placebo gum, indicating that instructions altered the reinforcing effectiveness of nicotine.

In a similar study, Hughes, Strickler, King, Higgins, Fenwick, Gulliver, and Mireault (1989b) gave two groups of cigarette smokers concurrent access to nicotine and placebo gums. One group, but not the other, was explicitly told that nicotine was available. Subjects who were informed of nicotine availability self-administered nicotine gum at a rate greater than placebo, but the uninformed subjects did not. As in the Hughes et al., (1985) study, it appears that instructions altered the reinforcing effectiveness of nicotine.

A third study by Hughes and his associates (Hughes, Gulliver, Amori, Mireault, & Fenwick, 1989a) found that, when cigarette smokers attempted to stop smoking, both receiving nicotine gum and receiving a placebo described as nicotine gum increased the number of days abstinent and decreased the number of cigarettes smoked. This outcome suggests that instructions alone may have therapeutic effects. Several other dependent variables were examined in this study, which used a three (instructed that the gum was placebo gum, nicotine gum, or unspecified) by two (placebo gum or active gum) factorial design. Some interactions between the two treatment variables occurred and the overall results indicated that "the effects of instructions and nicotine (1) are not mutually exclusive, (2) vary across independent variables, and (3) can interact such that instructions modify the therapeutic and subjective effects of nicotine" (Hughes et al., 1989a, p. 486).

Although the authors of a major review article (Hull & Bond, 1986) suggested that interactions between instructions and drug effects are relatively rare, at least when alcohol is the drug in question, the findings of Hughes et al., (1989a) indicate that such interactions do occur and, moreover, they can be quite powerful. In their study, instructions influenced whether nicotine produced *any* therapeutic, reinforcing, or subjective effects, not just the *magnitude* of these effects. Here, both the pharmacological effects of nicotine and instructions were important determinants of behavior. Rules (instructions) apparently altered the behavioral functions of the subjective effects of the drug. As Hughes et al., (1989a) noted in discussing gum self-administration, "when subjects are told they are receiving nicotine gum, the stimulus effects are probably labeled as indicators of therapeutic efficacy [which renders those effects positively reinforcing] whereas when told they received placebo, the same stimulus effects are labeled as side-effects [which renders them aversive]" (p. 490).

As a final example of the modification of drug effects by instructions, Bickel, Oliveto, Kamien, Higgins, and Hughes (in press) report that instructions can influence the discriminative stimulus actions of drugs. This study, in combination with the others reviewed here, make it clear that instructions can produce qualitative as well as quantitative changes in the effects of active drugs.

Rules also can modulate the effects of inert placebos, including whether or not they are self-administered. For instance, Chait and Perry (1992) examined the effects of instructions on self-administration and subjective effects of placebo marijuana. Two groups of regular marijuana smokers were given free access to placebo marijuana during four weekly one-hour sessions. One group was told that the marijuana was active, whereas the other group was told the marijuana might be inactive. Subjects who were told the marijuana was active reported greater subjective effects and smoked more placebo marijuana than the other group during the first session only. Instructions appear to have altered the reinforcing effectiveness of placebo marijuana, although this effect was short-lived. Interestingly, variables such as drug use history, current pattern of marijuana use, and personality measures correlated with the amount of placebo smoked. These variables may have influenced smoking directly, or by altering the effectiveness of instructions.

In another study demonstrating the modulation of placebo responses through instructions, Muntaner, Cascella, Kumor, Nagoshi, Herning, and Jaffee (1989) exposed cocaine-using subjects to three conditions. They were: (1) a drug condition in which subjects were told they might be given cocaine and actually received the drug intravenously; (2) a placebo condition in which subjects were told they might be given cocaine and actually received a placebo injection; and (3) a second placebo condition in which subjects were told they would receive a saline injection and actually received saline. When subjects were instructed that they might receive cocaine but in fact received placebo (condition 2), cardiovascular and subjective responses to placebo were similar to those produced by cocaine, although of lesser magnitude. Moreover, the heart rates of these subjects were significantly higher than those of subjects who were given placebo and told they were receiving placebo. This finding suggests that verbal instructions altered the conditioned eliciting function of injection-related stimuli.

In a third example of instruction-modulated placebo effects, Vuchinich and Sobell (1978) examined the effects of verbal instructions and alcohol on performance of a complex perceptual motor task. Subjects were moderate drinkers who either were or were not administered alcohol and either were or were not instructed that they were consuming alcohol. Reaction-time response errors were greater in the group that was told they received alcohol but actually did not than in the group that neither received alcohol nor such instruction. Moreover, a significant interaction occurred between drug condition and instruction type. As in the Hughes et al., (1989a) investigation with nicotine, summarized previously, the type of instruction presented influenced the kind of effects observed.

In general, it appears that instructions indicating that subjects will receive active drug increase the magnitude of placebo effects (Cami, Guerra, Ugena, Segura, & de la Torre, 1991; Chait & Perry, 1992; Hull & Bond, 1986; Kirsch & Weixel, 1988; Hughes et al., 1989a; Muntaner et al., 1989). The same kind of instructions also appears to increase placebo self-administration (Chait & Perry, 1992; Hughes et al., 1985; Marlatt, Demming, & Reid, 1973; Wigmore & Hinson, 1991).

SUMMARY AND CONCLUSION

The studies considered here by no means exhaust the store of articles relevant to the proposition that rules can significantly influence both the quantitative and qualitative effects of active drugs and placebos. But they do support that proposition. Certainly the rules, or instructions, that people are given concerning various substances can substantially alter the behavioral functions of those substances. Self-generated rules appear to be capable of doing the same. Consider an athlete who begins using anabolic steroids. It is probable that drug administration is preceded by the person covertly verbalizing something to the effect that "taking this will make me stronger." This rule describes a behavior (taking the steroid) and a desirable consequence of that behavior (getting stronger). Following the rule leads to the initiation and maintenance of such behavior. That this process works is evident by the fact that anabolic steroids have recently been classified as controlled substances — they have abuse potential. But this potential does not appear to reside in their immediate subjective effects. That is, unlike most abused drugs, they do not function as positive reinforcers in the absence of verbal mediation.

If this is true, we would not expect nonverbal organisms to self-administer anabolic steroids. As yet, no one has demonstrated that such drugs serve as positive reinforcers for nonhumans.[1] When drug-maintained behavior in humans and nonhumans are compared, there are remarkable similarities (e.g., Griffiths et al., 1980; Katz, 1990). But there are differences as well. One variable that may account for some of these differences is the presence of rule-governed behavior in our species.

This same variable may contribute to differences in drug effects across people. One of the beneficial effects of rules is to bring behavior under the control of long-delayed consequences; another is to bring behavior under the control of consequences that would be harmful if directly experienced. Although this possibility is difficult to test empirically, it may be that drug self-administration in drug abusers is controlled primarily by its immediate pharmacological consequences; the repertoire is not rule-governed. Or it may be that such people follow rules that generate harmful patterns of self-administration (e.g., "I can have one more and drive O.K.; I've done it before"). In contrast, people who use drugs responsibly appear to generate and follow gainful rules (e.g., "I'd better switch to soda; I have to drive home").

Behavior analysts have only recently begun to explore the variables that control rule generation and rule following (e.g., Hayes, 1989). Like contingency-shaped behavior, rule-governed behavior is operant behavior. All operant behavior is plastic; it varies within and across people as a function of historical and current variables. Those variables reside in the environment, and are potentially capable of being measured and manipulated.

The simple fact that the control of rule-governed behavior resides in the environment, not in cognitive processes, is the primary advantage of emphasizing rules (or instructions), not expectancies, as determinants of drug effects. Although self-generated rules and expectancies may share topographical and functional similarities, the conventional approach to expectancies is cognitive. For example, in discussing their expectancy-attribution model of placebos, Ross and Olson (1981) indicate that, "The model is perhaps most easily presented in terms of the 'mental arithmetic' that is hypothesized to mediate subjects' reactions to placebos" (p. 412). From a behavioral analytic perspective, mental arithmetic is not a good explanation of placebo effects.

In fact, from that perspective, the effects of placebos and of active drugs alike are explained when the conditions under which they do and do not occur, and the variables that modulate their occurrence, can be precisely specified. Once those variables are known, they can in principle be altered to change drug-related behavior in desired fashion. This commentary has emphasized that rules play a part in determining how people use drugs, and the effects that those drugs produce. Most

[1]Scientists don't prove negatives, and it is possible that anabolic steroids serve as positive reinforcers for nonhumans under certain, presently unspecifiable, conditions. This appears unlikely, however, and there are several other drug classes (e.g., antibiotics, analgesics such as aspirin) that humans, but not nonhumans, self-administer. Rule-governance appears to provide a reasonable account of this general phenomenon.

important drug-related behavior in humans is operant, and operant behavior is either rule-governed or contingency-shaped. Although the direct behavioral effects of drugs can never be ignored, the presence or absence of appropriate rule-governed behavior may play an important role in determining whether or not a particular person develops a pattern of drug abuse and, if so, how well that person responds to treatment. A significant challenge for all behavior analysts is developing strategies that foster strong and socially-appropriate rule-governed behavior in all individuals who lack such a repertoire, including drug abusers. Among those best prepared to meet that challenge are readers of this journal.

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